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मानक

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IS 2800-1 (1991): Code of Practice for Construction and Testing of Tubewells/Borewells, Part 1: Construction [MED 21: Diamond Core and Waterwell Drilling]



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भारतीय मानक

नलकूप/वेधकूप की संरचना और परीक्षण की
रीति संहिता

भाग 1 संरचना

(दूसरा पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION
AND TESTING OF TUBEWELLS/BOREWELLS

PART 1 CONSTRUCTION

(Second Revision)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pumps Sectional Committee had been approved by the Heavy Mechanical Engineering Division Council.

This Code of practice was first published in 1964 and revised in 1979 for splitting the requirements in following two parts:

**IS 2800 (Part 1) Code of practice for construction and testing of tubewells: Part 1
Construction**

IS 2800 (Part 2) Code of practice for construction and testing of tubewells: Part 2 Testing

This standard is again revised to cover the latest developments in the field of tubewell/borewell construction.

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION AND TESTING OF TUBEWELLS/BOREWELLS

PART 1 CONSTRUCTION

(Second Revision)

1 SCOPE

This Code applies to drilling and construction of tubewells/borewells for agriculture, drinking water, industrial and other allied purposes. It gives only general guidance as regards, design, drilling and construction of tubewells/borewells. Other improved method of construction, if any, may be adopted with prior agreement between the drilling agency and the well owner.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
226 : 1975	Structural steel (standard quality) (<i>fifth revision</i>)
4097 : 1988	Gravel for use as pack in tube-wells
4270 : 1983	Steel tubes used for water wells (<i>first revision</i>)
8110 : 1985	Well screens and slotted pipes (<i>first revision</i>)
9439 : 1980	Glossary of terms used in water-well drilling technology
10500 : 1983	Drinking water
11189 : 1985	Methods for tubewell development
12818 : 1989	Unplasticized PVC ribbed screen casing and plain casing pipes for bore/tubewells — Specification

3 TERMINOLOGY

For the purpose of this standard, definitions of the terms generally used in tubewell drilling technology specified in IS 9439 : 1980 shall apply.

4 TYPE OF TUBEWELLS

4.1 Type 1 (Cavity Well)

Cavity wells are generally shallow wells drilled in alluvial formations (*see Fig. 1A and Fig. 1B*). These are wells with casings resting in thick,

hard impervious clay layer above the aquifer. It is a pre-requisite that the impervious clay layer should be of adequate thickness to support the well and should not disintegrate when water is pumped out.

4.2 Type 2 (Tubewell)

Tubewells are generally constructed in alluvial formations comprising a casing pipe, a housing pipe (if need be) and an intake section either screen or slotted pipe with or without gravel packing (artificially packed or naturally packed wells as shown in Fig. 2A and Fig. 2B). These wells may be either under water table conditions or under artesian conditions (*see Fig. 2C*).

4.3 Type 3 (Borewell in Hard Rock Formation)

The over-burden in such wells is encased to eliminate the risk of caving in. Drilling is further carried out in rock formation and the bore is left normally unsupported to allow the water to flow from crevices and fishers into the bore except in cases where caving formations are encountered (*see Fig. 3*).

5 DRILLING METHODS

5.1 Auger Drilling

The drilling is done with a spiral or worm auger connected to square rods turned manually with rod tillers, the cuttings produced as a result of drilling are removed with a sand shell. Steel casing pipes with drive shoes at the bottom are lowered as the drilling progresses. This method is employed where very shallow drilling in alluvium formation is involved (*see Fig. 4A and Fig. 4B*).

5.2 Water Jet Boring

A drill bit with nozzles is attached to the drill pipes at its bottom and through which water is pumped at high pressure. The water on its return flow through the annular space between the bore and the drill pipe, brings out the cutting along with it to the surface. Casing pipe is simultaneously used to avoid caving-in. The method is suitable for drilling shallow wells in loose sandy formations (*see Fig. 5*).

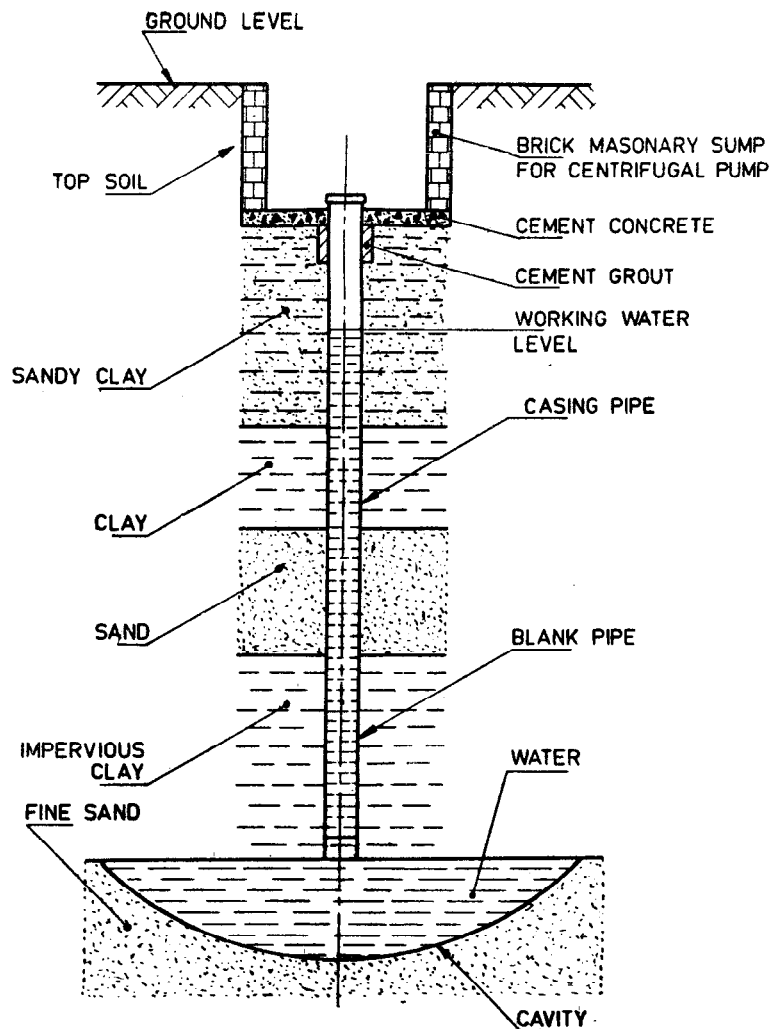


FIG. 1A CAVITY WELL (FOR CENTRIFUGAL PUMP)

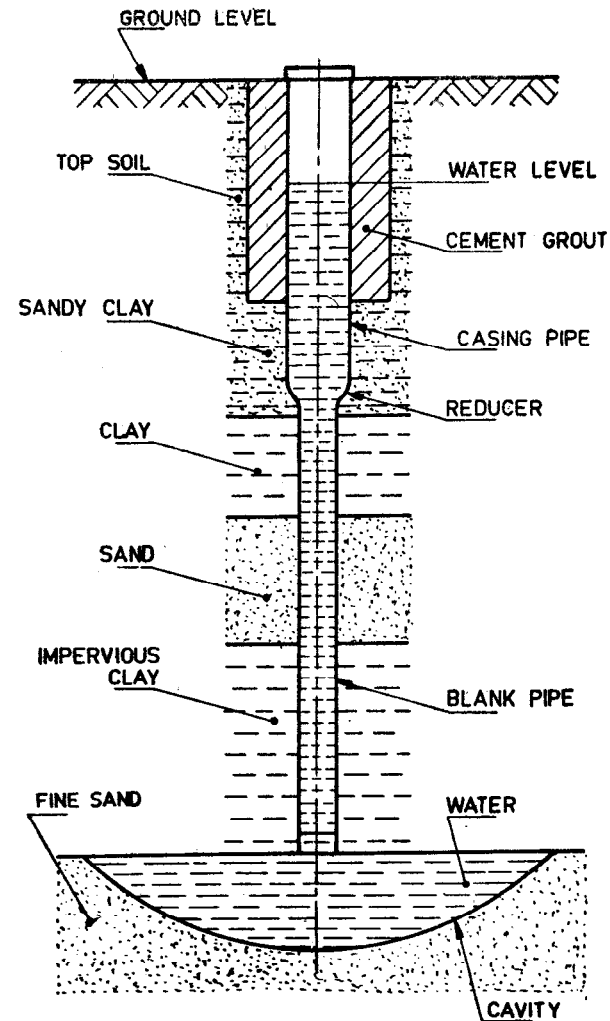


FIG. 1B CAVITY WELL (FOR TURBINE SUBMERSIBLE PUMP)

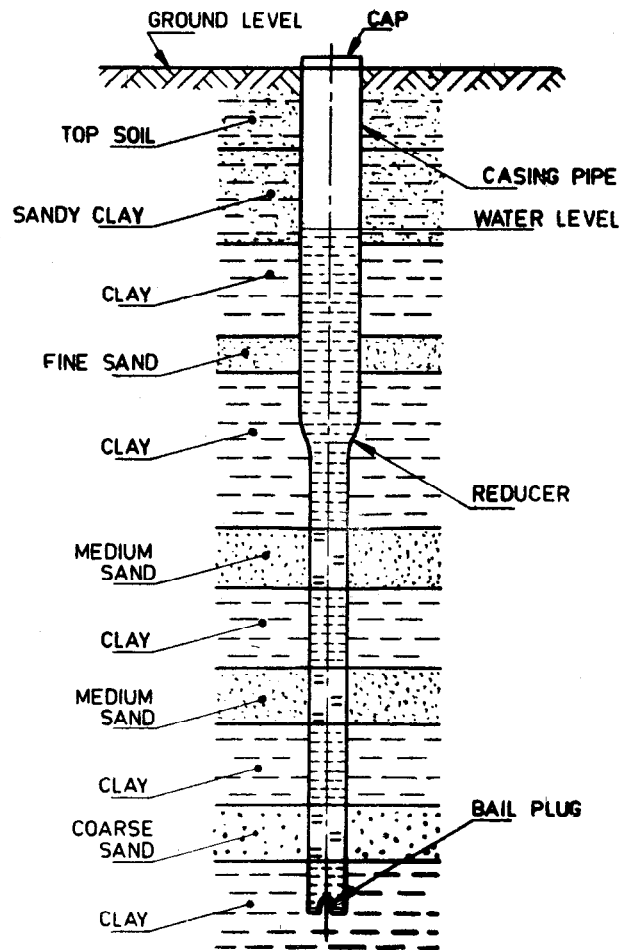


FIG. 2A TUBEWELL (NATURAL GRAVEL PACK)

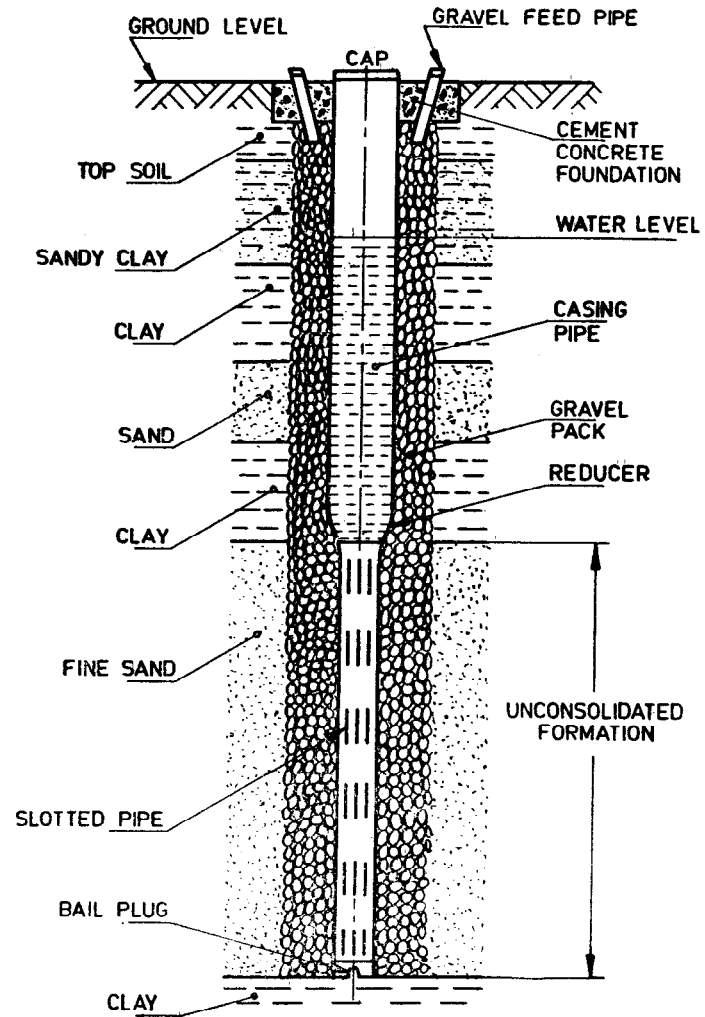


FIG. 2B TUBEWELL (ARTIFICIAL GRAVEL PACK)

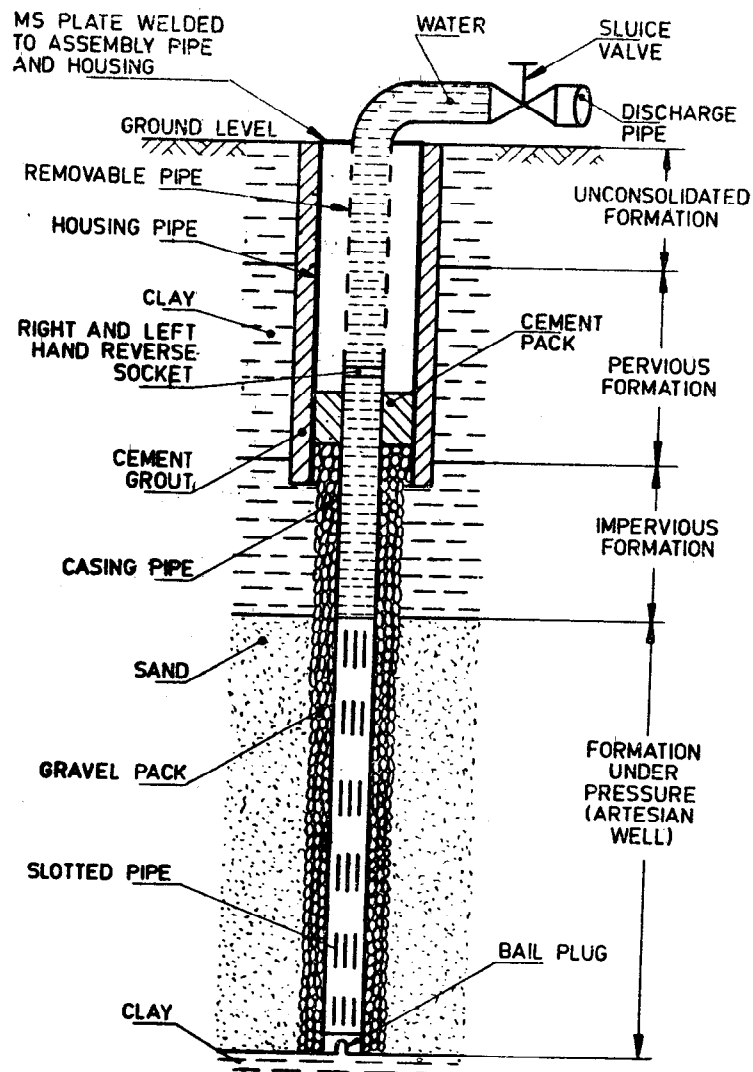


FIG. 2C TUBEWELL (ARTESIAN FLOWING)

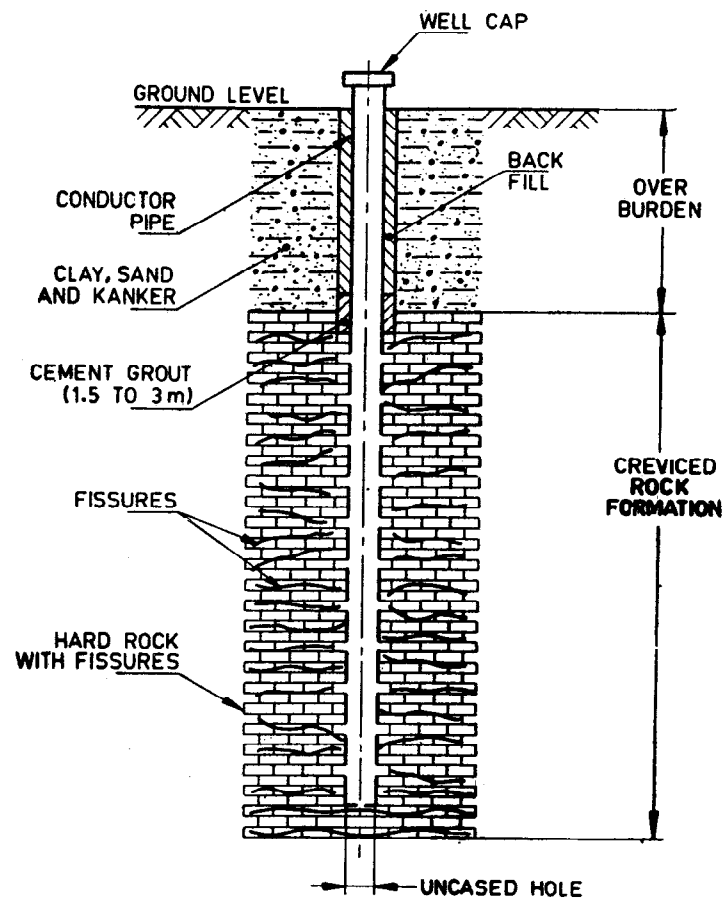


FIG. 3 BOREWELL IN HARD ROCK

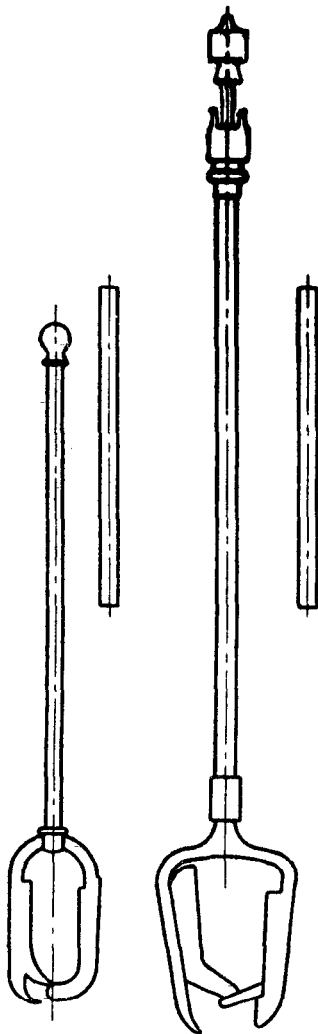


FIG. 4A HAND AUGER

5.3 Calyx Drilling

A bit made from hollow steel tube with two inclined slots called 'shot bit' is connected below another tube (core barrel) which is further connected to the drill rods. These are rotated mechanically. Chilled shots are fed to the bottom of the bit through the drill string along-with water. These are ground by the shot bit to form abrasive material with sharp edges which cuts into the consolidated formation forming an annular ring to form a core inside the core barrel, which is then taken out from well by grouting the core with quartz chips, etc. This method is successful for shallow tubewells drilling in consolidated formations with large diameter holes.

5.4 Percussion Drilling

A heavy bit attached with a drill stem, a drilling jar to a cable is given up and down spudding motion, either manually or by power. Water is added to dissolve the cuttings which are lifted

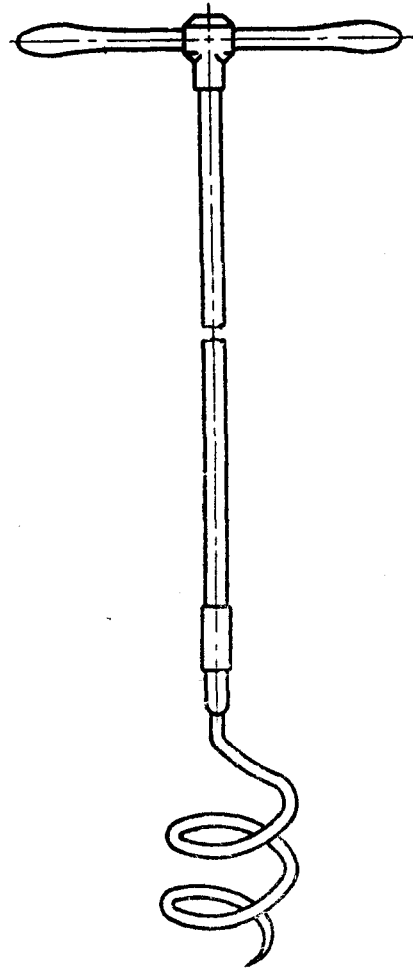


FIG. 4B SPIRAL AUGER OR RAM'S HORN

out by means of a bailer. Steel casing pipes with drive shoes are used as the hole progresses. This method of drilling is suitable for drilling in bouldery formations.

5.5 Rotary Drilling

5.5.1 Direct Circulation Method

A drill bit is rotated mechanically by means of drill pipes, through which drilling mud (usually bentonite mixed with other suitable material) is circulated under pressure. This process of circulation lubricates the bit, carries the cutting in suspension to the surface and also plasters the wall of the hole to prevent it from caving-in. Very deep wells can be constructed in alluvium formations by this method.

5.5.2 Reverse Circulation Method

A starting of drill pipes with a drill bit at the bottom is rotated by mechanical means. Plain water or a fluid of gelling quality depending on the strata conditions, is allowed to flow into the bore hole, when drill cuttings along with water are sucked through the drill pipes by a centrifugal pump and thrown into the setting pit. The

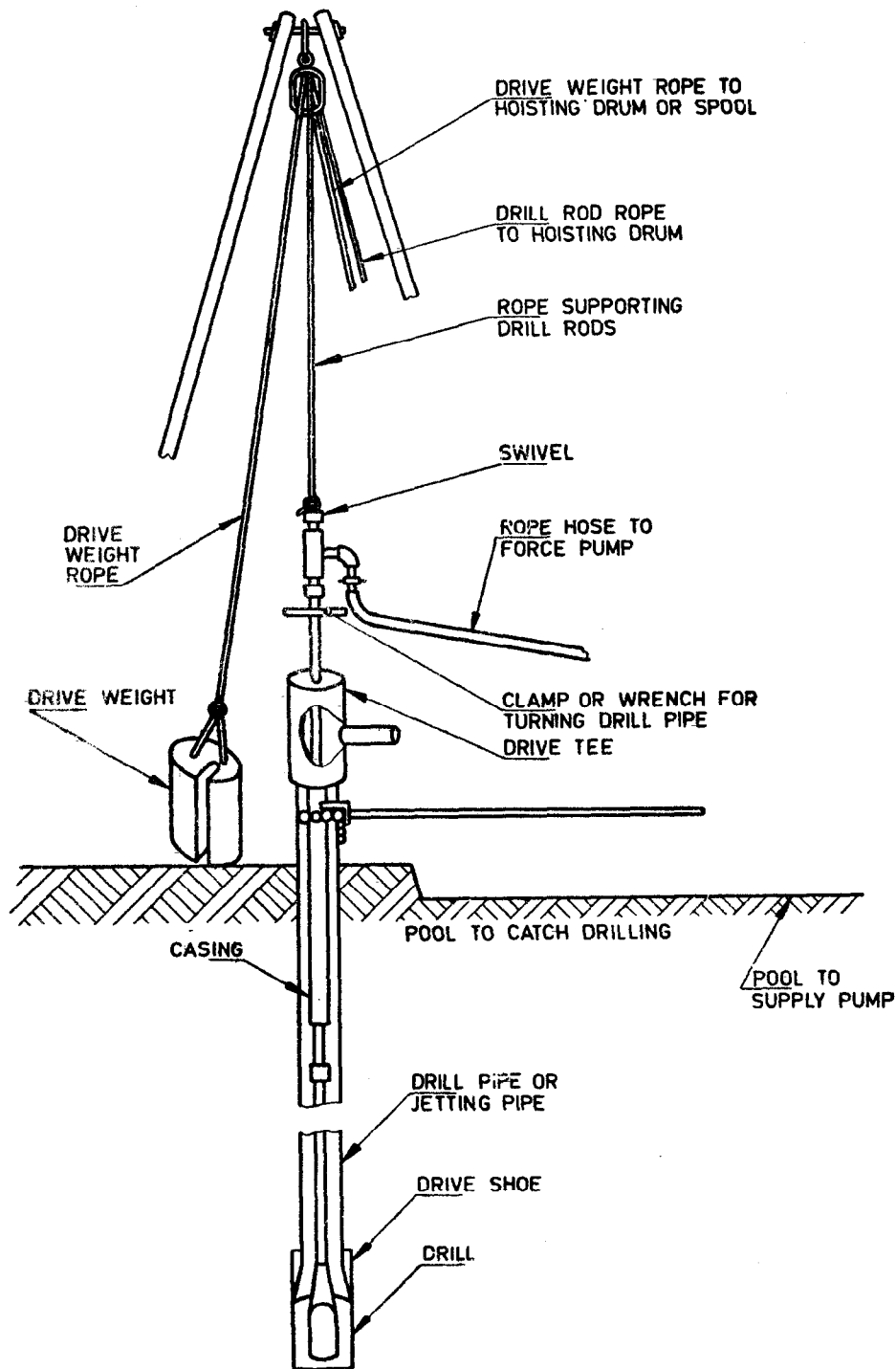


FIG. 5 SIMPLE JETTING RIG

hole remains intact under the hydrostatic pressure of the drilling fluid, the level of which is maintained continuously. Large diameter holes can be drilled in alluvium formations by this method.

5.6 Down the Hole Hammer (DTH) Drilling

The method is used for fast and economical drilling in hard formations. Compressed air is

utilized for rapid impacting action by the hammer to the bit thus crushing the formation into small chips which are flushed out through the annular space between the bore and the drill pipes by the upcoming compressed air.

5.7 The drilling bits generally used during the drilling by direct circulation method and by reverse circulation method are tricone rock

roller bits, diamond drilling bits, reaming bits and thin wall core bits. Their use depends upon the type of soil formations such as soft, medium hard and hard formations. The bits used for percussion drilling are california pattern bits and for DTH drilling are button bits and drag bits.

6 ACCESSORIES

6.1 The accessories commonly used for tubewell construction, their description/functions and the typical material for their manufacture are given in Table 1.

6.2 A typical drawing showing details of bail plug, bail plug hook, centralizer, taper reducer, mild steel clamp, well cap and notch plate, is given in Fig. 6.

7 INFORMATION TO BE FURNISHED BY THE OWNER OF THE TUBEWELL

The owner shall furnish the following information to the drilling agency:

- Information regarding tubewells and dug well, existing near his land. Their depth, formation encountered and discharge, etc, may be furnished as far as possible;
- Static water level;
- Expected yield;
- Purpose for which the water is needed, such as irrigation, industrial or domestic purpose, etc; and
- Any other information.

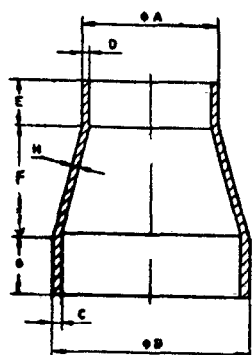
8 INFORMATION TO BE FURNISHED BY DRILLING AGENCY

When offering to sink a tubewell, the drilling agency shall furnish the owner with the following information:

- Suitably of the site proposed by the owner (if a more suitable site, other than the one proposed by the owner is available, it should be suggested);
- Whether a test bore hole is proposed and if so, its diameter and depth, and also depth of production tubewell proposed;
- Likelihood of increase or decrease of the depth given at (b) above;
- Method of drilling with size of bore in different depths;
- Types of plain pipe with size, wall thickness and slotted/strainer pipes with opening, may be mentioned;
- Guarantee with regard to the verticality of tubewell and sand content (ppm) in the discharge from the well at the time of handing over;
- Development methods to be adopted may be stated; and
- Any other information and conditions.

Table 1 Nomenclature of Tubewell Parts
(Clause 6.1 and Fig. 1, 2 and 3)

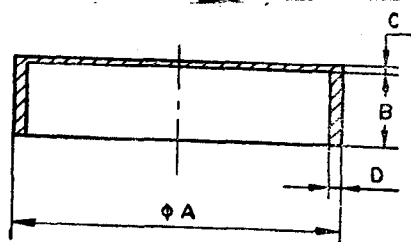
Sl No. (1)	Name of Part (2)	Description/ Function of Part (3)	Typical Materials (4)
1)	Bail plug or bottom plug	A closed socket provided at the bottom most end of the pipe assembly. A simple mild steel plate welded at the bottom end.	IS 226 : 1975
2)	Bail plug hook	Inverted 'U' hook attached to the bottom plug or a bar fitted across the blind pipe.	IS 226 : 1975
3)	Casing pipe	Placed against strata from which water is not to be tapped.	IS 4270 : 1983 or IS 12818 : 1989
4)	Screens/ slotted pipes	Has openings to permit entrance of water from the aquifer.	IS 8110 : 1985
5)	Centralizer	The centralizing guides are fitted to the well assembly except the housing pipe at suitable spacing to keep the assembly in the centre of the hole so that an even thickness of gravel pack.	IS 226 : 1975
6)	Taper/reducer	A taper/reducer is intended to connect the housing pipe with lower diameter assembly down below.	IS 226 : 1975
7)	Housing pipe	This is the upper portion of the case section of the well and serves as a housing for the pumping equipment and is a vertical conduit through which water flows from the aquifer to the pump. It is water tight and extends downwards from ground surface to a depth below the anticipated pumping water level.	IS 4270 : 1983
8)	Clamp	Fixed at the top of the tubewell for supporting the well assembly.	IS 226 : 1975
9)	Well Cap	Used to keep the tubewell closed after its completion until the pump set is installed. It is either threaded to be screwed to top of the housing or simply a plate is spot welded so as to be easily removed when required.	IS 226 : 1975



6A Taper Reducer (Unthreaded)

All dimensions in millimetres.

Size of Reducer	A	B	C	D	E	F	G	H
300×200	237	348	16	12	80	200	100	12
350×200	237	380	16	12	80	200	100	16
400×200	237	430	20	12	80	200	100	16

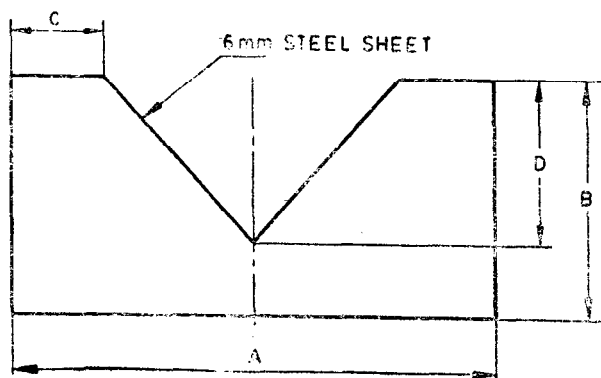


6B Well Cap (Unthreaded)

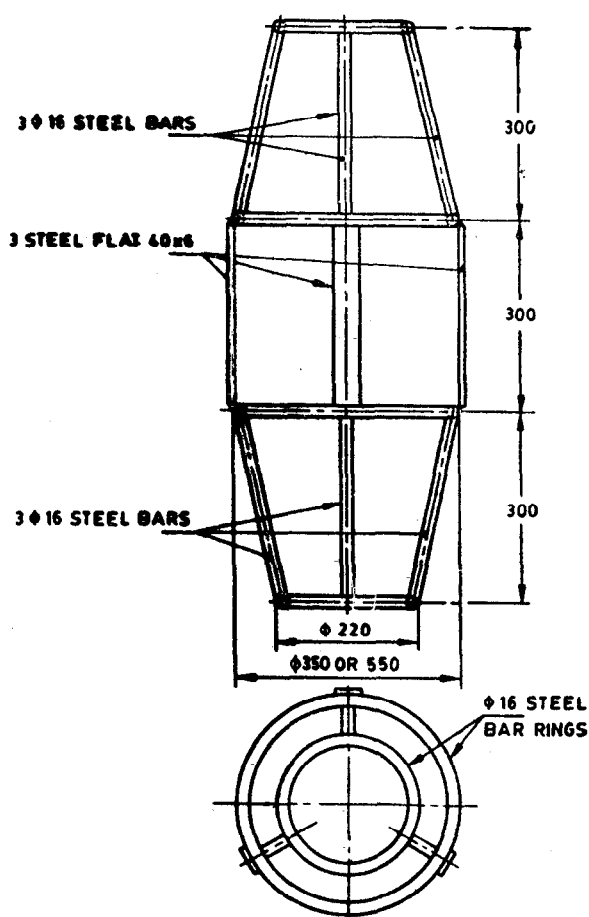
All dimensions in millimetres.

Size of Well Cap	A	B	C	D
300	348	80	6	12
350	372	80	6	12
400	430	80	6	16

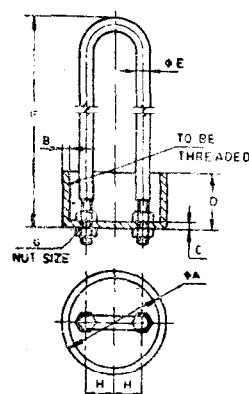
6B Well Cap (Unthreaded)

6C V-Notch Plate
All dimensions in millimetres.

Size of V-Notch	A	B	C	D
225	650	325	100	225
300	900	450	150	300
375	1 050	450	150	375
450	1 200	600	150	450
600	1 500	750	150	600



6D Centralizing Guide

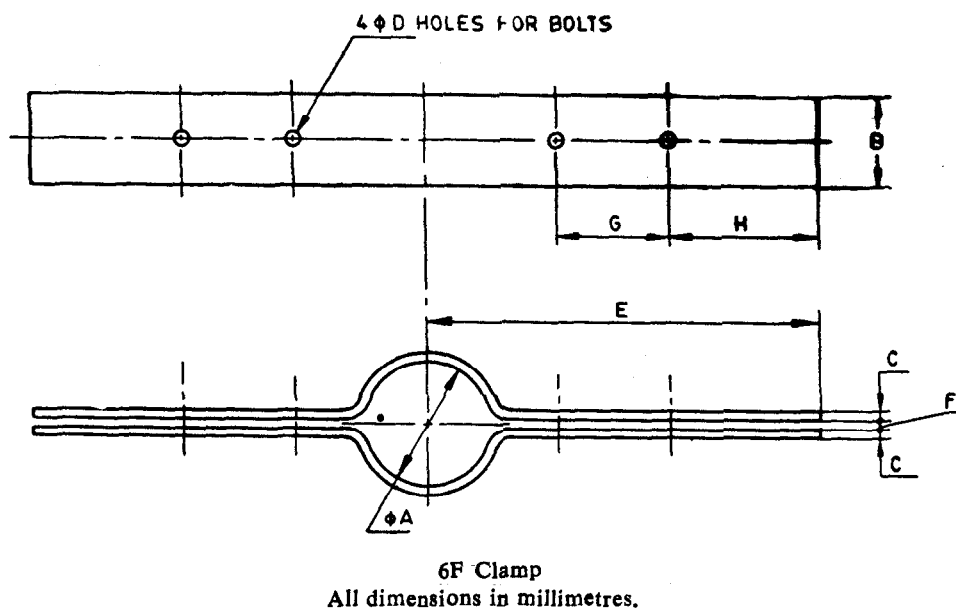


6E Bail Plug

All dimensions in millimetres.

Size of Bail Plug	A	B	C	D	E	F	ϕG	H
150	186	12	12	100	25.0	500	20	50
200	237	12	12	100	25.0	500	20	55

FIG. 6 TYPICAL DETAILS OF TAPER REDUCERS, WELL CAP, V-NOTCH PLATE, CENTRALIZING GUIDE, BAIL PLUG AND CLAMP



Size of Iron Clamp	A	B	C	D Dia	E	F	G	H
150	168.3	100	12	18	525	12	150	200
200	218.1	100	12	20	600	15	150	290

FIG. 6 TYPICAL DETAILS OF TAPER REDUCER, WELL CAP, V-NOTCH PLATE, CENTRALIZING GUIDE, BAIL PLUG AND CLAMP

9 GENERAL REQUIREMENTS

9.1 Design and Lowering of Pipe Assembly

9.1.1 Design of Pipe Sizes and Lengths

The length and diameter of the casing pipe is selected on basis of static water level, the draw down, the discharge expected from the well and the size of pump to be installed. The size and length of slotted/strainer pipes are selected according to the actual requirement according to the strata met with, the expected discharge and the depth of tubewell. The casing pipes shall generally conform to IS 4270 : 1983 and the slotted/strainer pipes shall conform to IS 8110 : 1985.

9.1.2 Design of Screen Slots

The entry of water in the tubewell shall be either through screens or slotted pipes. Following are the various types of well screens and slotted pipes used in water wells depending upon the type and size of well:

- Plain slotted pipe,
- Bridge slotted pipes,
- Mesh wrapped screens,
- Cage type wire wound screens,
- Pre-packed resin bonded gravel screens, and
- Brass screens.

The design, selection and type of screen or slotted pipe, size and distribution of slots shall be as specified in IS 8110 : 1985.

9.2 Gravel Packing

9.2.1 All gravel to be used as pack in tubewell construction shall be as specified in IS 4097 : 1967. The thickness of the gravel shroud around the screen shall generally be not less than 10 cm.

9.2.2 In percussion method of drilling, gravel is fed into the annular space between the casing pipe and the assembly pipe up to 3 m. above the bottom of the slotted pipe. The well is developed using compressed air or by bailers and as the water becomes clear, surging or backwashing is done to make the development more perfect. More gravel is fed, if necessary, and when the water becomes free from sand, the casing pipe is jacked up to some height, and the process is repeated until all the aquifers are gravel packed.

9.2.3 In rotary method, the pipe assembly is lowered into position and gravel packing may be done up to a suitable depth below the bottom of the housing pipe in the first instance. Thereafter the gravel packing up to the required depth is completed after keeping the housing pipe vertical within limits. To achieve uniform gravel packing around the pipe assembly inverted cones should be used.

9.2.4 A provision for a well base to eliminate the possibilities of subsidence of the well structure may be incorporated. If the bottom of the well is in a soft formation, the well should be provided with an artificial base for the casing and screen by overdrilling the hole about 1 to 2 m and filling the extra depth with concrete or gravel.

9.3 Development of Tubewell

9.3.1 The drilled well shall be developed by any of the methods specified in IS 11189 : 1985 depending upon the site conditions in order to get maximum sand free yield. The development process shall be continued until the stabilization of sand and gravel pack has taken place.

9.3.2 The development of the tubewell by overpumping should be done at 15 percent to 25 percent higher discharge than the expected discharge from the tubewell. The final discharge should be free from sand with a maximum tolerance of 20 parts of sand in one million parts of water by volume after 20 minutes of starting the pump.

9.3.3 In case of tubewells for drinking water, the discharge shall be totally sand free. If the discharge is not sand free after 20 minutes of starting the pump, the well shall be redeveloped. In case the discharge is still not sand free even after re-development, the pump set of lesser discharge capacity may be installed to get sand free water suitable for drinking. The turbidity and hardness of water of wells used for drinking purposes, shall be as specified in IS 10500 : 1983.

9.4 After completion of development by overpumping, the well shall be tested for its performance, that is yield characteristics and efficiency. This shall be achieved by conducting a step draw down test-determine draw downs at the end of the hour by pumping at 3 to 4 different rates of discharge.

10 DISINFECTION

10.1 The well shall be disinfected after completion of test for yield. All the exterior parts of the pump coming in contact with the water shall be thoroughly cleaned and dusted with powdered chlorine compound. In fact it should be disinfected every time a new pump is installed or the one replaced after repairs.

10.2 A stock solution of chlorine may be prepared by dissolving free chlorinated lime. For obtaining an applied standard concentration of 50 ppm. One litre of the stock solution should be used to treat 300 litres of water.

10.3 In case of waterwells for drinking water purposes, the quality of water should be as laid down in IS 10500 : 1983.

11 GROUTING AND SEALING

11.1 Grouting and sealing of tubewell may be done, if required by the owner, depending upon the site conditions and quality of the discharge of the strata encountered. To ensure that the grout will provide a satisfactory seal, it should be applied in one continuous operation. Sealing of the tubewell may be done by grouting the annular space between bore and the housing pipe, thickness of grouting depending upon the quality of water. In case of tubewells for drinking purposes, grouting and sealing shall always be done to ensure safe sanitary conditions.

11.2 It is desirable to plan an oversize bore hole of 7.5 to 15 mm more than the diameter of the well casing to an adequate depth during the design of well itself. The depth to be grouted varies with geologic and site conditions but a depth of 3 to 4.5 m from the surface is generally adequate.

11.3 Surface Apron

An apron around the well and sloping away from it protects the well from pollution caused by contaminated water flowing back into it and prevents muddy pools of standing water forming around the well.

12 HANDING OVER OF THE TUBEWELL

12.1 The tubewell should be handed over to the owner in a complete shape. The housing pipe should be closed by a well cap for the period between the completion of the tubewell and the installation of the pump set.

12.2 The following information shall be furnished by the drilling agency on completion of the tubewell:

- a) Total depth of tubewell drilled,
- b) Strata chart of the tubewell indicating different type of soil formations met with at different depths and indicating the depth of each type of soil formation,
- c) Samples of strata collected, neatly packed and correctly marked in sample bays,
- d) Position of every joint in well assembly,
- e) Method used for development,
- f) Total hours of development done,
- g) Developed discharge in L.P.S.,
- h) Discharge is totally sand free or presence of sand particles is there,
- j) P.P.M. and turbidity after development,
- k) Pumping water level at developed discharge, and
- m) Static water level.

12.2.1 A typical proforma is given in Annex A to furnish the details given in 12.2.

ANNEX A

(Clause 12.2.1)

INFORMATION TO BE FURNISHED BY DRILLING AGENCY TO OWNER ON COMPLETION OF TUBEWELL

- | | | | | | | | | | | |
|--|-------|------------|------------|-------|-------|-------|-------|-------|-------|--|
| <p>1. Agency drilling the tubewell.....</p> <p>2. Location of the tubewell.....</p> <p>3. Method of drilling adopted.....</p> <p>4. Date of starting.....</p> <p>5. Date of completion.....</p> <p>6. Pilot hole or test hole.....Bit size.....
Bit type.....Hours.....from.....
to.....</p> <p>7. Coring done.....Bit size.....Bit
type.....Hours.....Recovery.....
.....from.....to.....</p> <p>8. Reaming.....Bit size.....
Bit type.....Hours.....from.....
.....to.....</p> <p>9. Lithological data</p> <table border="0" style="width: 100%;"> <tr> <td style="text-align: center;">From</td> <td style="text-align: center;">To</td> <td style="text-align: center;">Formations</td> </tr> <tr> <td>.....</td> <td>.....</td> <td>.....</td> </tr> <tr> <td>.....</td> <td>.....</td> <td>.....</td> </tr> </table> <p>10. Total depth of tubewell drilled.....</p> | From | To | Formations | | | | | | | <p>11. Assembly of production well..... Size.....
Length..... Type.....
Perforation per metre.....
Housing pipe.....
Blind pipe.....
Strainer.....
Bail plug.....</p> <p>12. Top of tubewell above/below ground
level.....</p> <p>13. Size of gravel..... Quantity used before
development..... Quantity used during
development.....</p> <p>14. Method used for development.....
Total hours of testing.....</p> <p>15. Development discharge.....</p> <p>16. Turbidity.....</p> <p>17. Further details appended:
a) Samples of strata, neatly packed in
sample bags,
b) Chart of pipe assembly lowered, and
c) Results of mechanical analysis of samples
of unconsolidated strata.</p> <p>18. Remarks:
Owner..... Driller.....</p> |
| From | To | Formations | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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